



RAMANtouch, RAMANwalk, and RAMANdrive

# Nanophoton Series Raman Microscopes

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Rethink Raman Imaging.

Innovation with Integrity

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## Meet the **RAMAN**family

Beauty in simplicity – Strength in innovation. Both define our Nanophoton series Raman imaging microscopes. By using galvanometric scanning, we provide the higher measurement speed, higher spectral quality, and unmatched performance needed to rethink Raman imaging.

Every microscope in the RAMANfamily shares a key technological feature: our patented galvanic beam steering for controlling the optical path of laser excitation and Raman signal collection. This opens up new possibilities that each of the Nanophoton devices uses in its very own way.



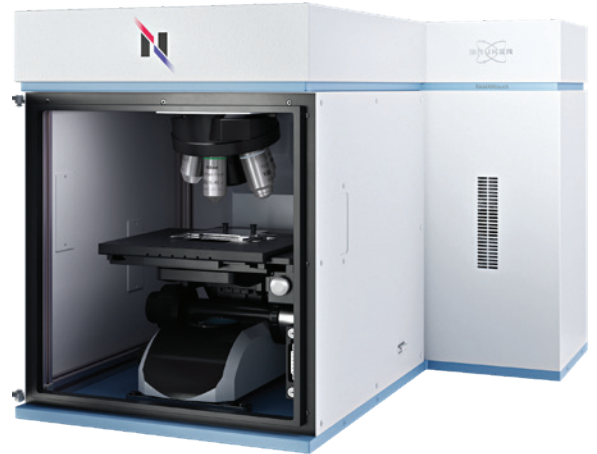
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# RAMANtouch | Rethink Raman Imaging

RamanTouch™ is the flagship Nanophoton Raman microscope, delivering ultrafast Raman imaging at the highest spatial resolution without compromise. Powered by Raman line imaging with galvanometric scanning, it enables its users to acquire large-area Raman maps in minimal time while preserving maximum detail and accuracy. It is built for users who need the highest level of imaging performance and throughput.

## RAMANtouch

- Line illumination capturing 400 spectra simultaneously
- AreaFlash™ imaging for quick large-area average spectra
- Ultra-fast 2D and 3D Raman imaging speed
- Highest spectral and spatial resolution
- Fully automated hardware, including calibration and alignment
- Support for up to four lasers in parallel
- Dedicated wafer analysis system available (RAMANdrive)
- Class 1 laser safety housing

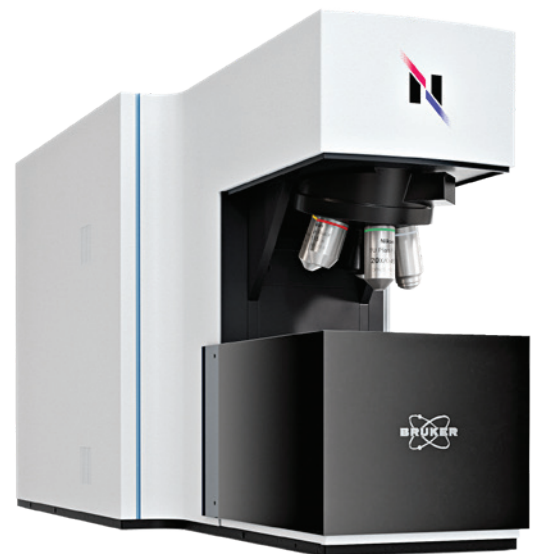


# RAMANwalk | Make Raman Smarter

RamanWalk™ brings intelligent Raman imaging to everyday workflows by combining advanced laser beam steering with stochastic, random-walk imaging. Designed for efficient overview scans and smart region-of-interest selection, it delivers fast, high-quality Raman results while reducing unnecessary data acquisition. RamanWalk™ is the efficient solution for intelligent exploration and routine Raman imaging.

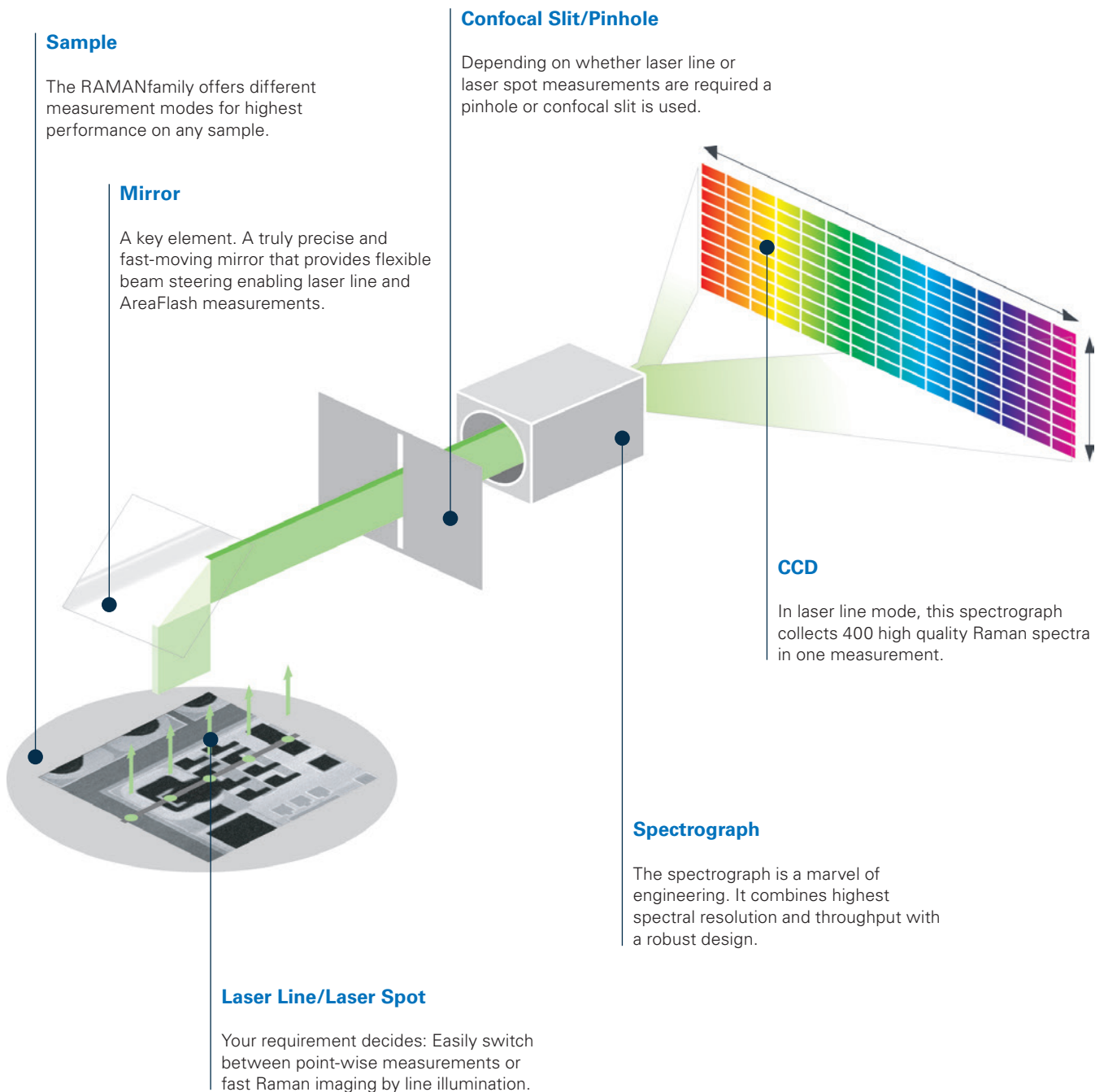
## RAMANwalk

- Reduced imaging time via smart acquisition algorithm by RandomWalk™
- Fast overview and preview images
- Confocal design for depth-resolved analysis
- Convenient 2D and 3D Raman imaging
- Completely automated hardware, including calibration and alignment
- Compact footprint and open access design
- 532 nm and 785 nm laser setup
- Class 1 laser safety housing



# Our Core Technology

Galvanometer scanners allow fast and accurate laser beam scanning and steering. This means the laser spot can travel across the sample, without moving the microscope's stage, speeding up analysis and eliminating vibrations. In combination with Nanophoton's patented line illumination technology, this sets the foundation for highest imaging performance on any sample.

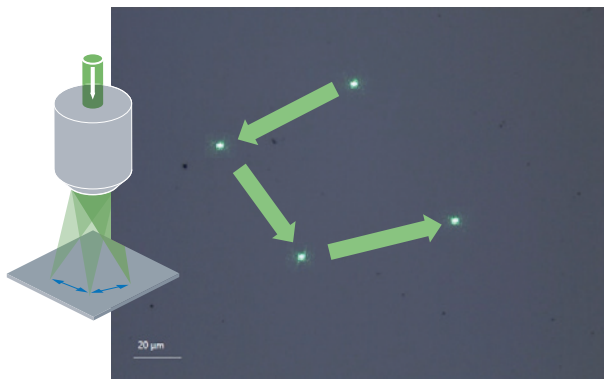


# Measurement Modes

The RAMANfamily offers different measurement modes to deliver optimal performance for different samples. The dedicated illumination mode developed by Nanophoton has dramatically improved the speed of Raman imaging by re-forming point laser beams into line shapes to cover a larger sample area.

## Laser Spot Illumination

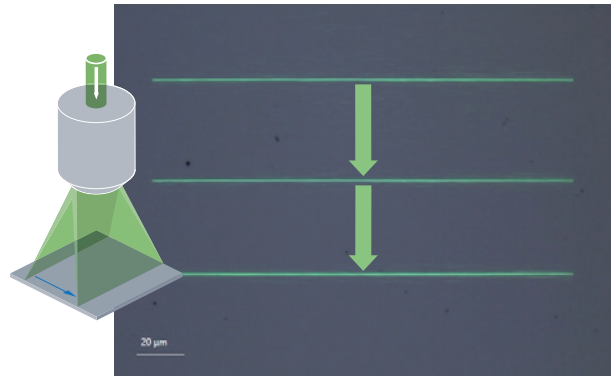
RAMANdrive, RAMANtouch, RAMANwalk



With laser beam scanning, both scanning speed and scanning accuracy are far superior to conventional motorized scanning. In addition, the measurement position can be specified by simply clicking on any position in the microscope image without requiring to move the sample.

## Laser Line Illumination

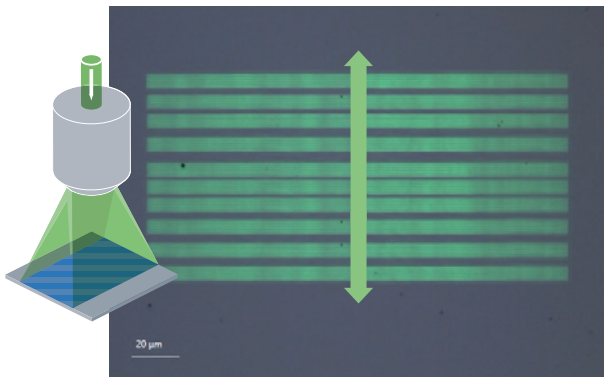
RAMANdrive, RAMANtouch



Using a laser line let's you spend your time 400 x more efficiently. Scattered light is detected by the two-dimensional CCD, obtaining 400 spectra with a single exposure. The Galvanometer scanners enable Raman imaging of several hundred thousand pixels within just a few minutes.

## AreaFlash Illumination

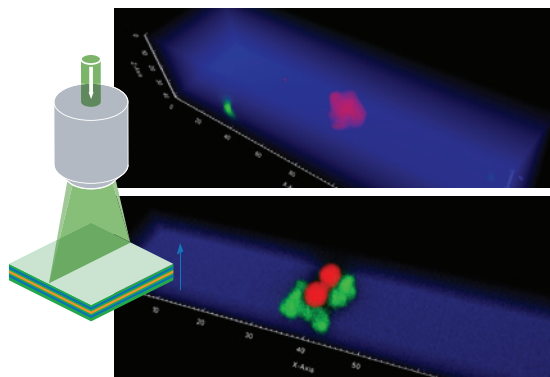
RAMANdrive, RAMANtouch



The laser flashes across the sample, covering the entire field of view with a continuously moving laser line. AreaFlash provides an average spectrum of a large area (>1.5\*1.5mm with 5x objective lens). With this, you can quickly obtain a comprehensive Raman image of a large area. For photosensitive samples, AreaFlash mode minimizes effective laser intensity, preventing alteration of the substances.

## 3D Imaging

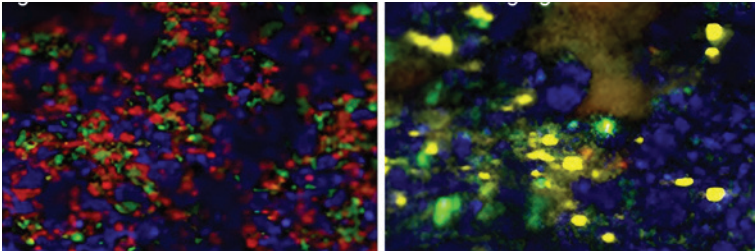
RAMANtouch, RAMANwalk



Spot- and line illumination can be used to automatically perform 3D Raman imaging on transparent samples. The speed advantage of the line illumination technique for the first time gives access to three-dimensional information on chemical distributions within manageable timeframes.

# Raman Applications

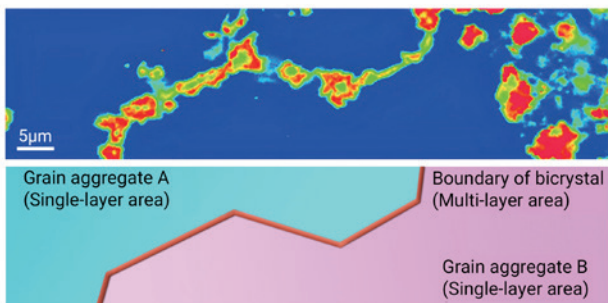
## Battery Research - Monitoring Electrodes



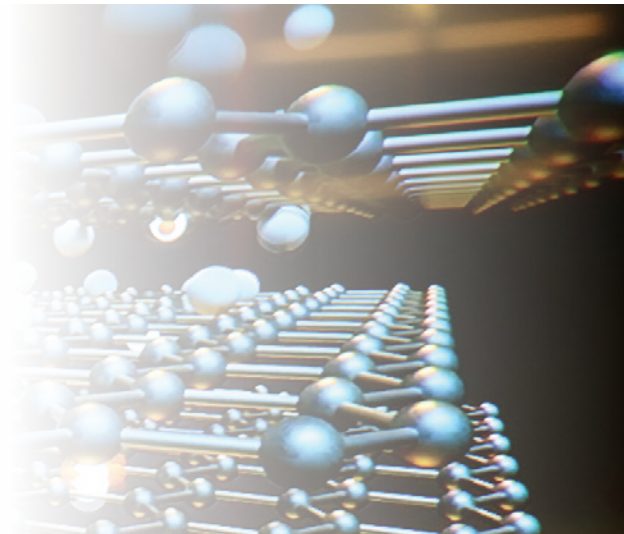
This example focuses on improving high-capacity lithium-ion battery negative electrodes. The approach involves examining the structural changes of silicon through Raman imaging before and after charging. Raman imaging identifies the transformation of crystalline silicon into an amorphous state due to volume changes. This transformation can lead to issues like irreversible capacity loss, structural degradation, altered diffusion kinetics, and electrode instability.



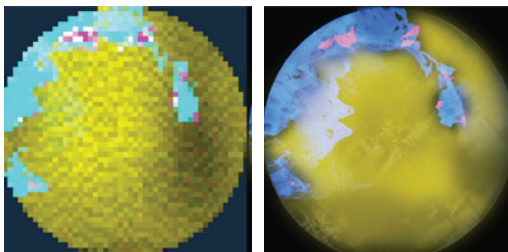
## Carbon Materials - CVD Graphene Growth



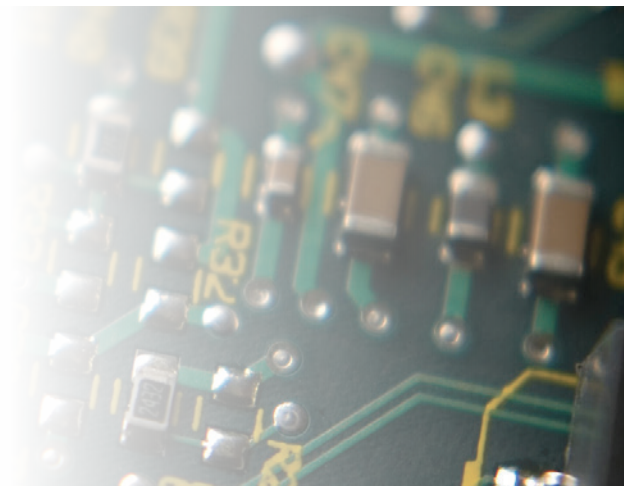
Graphene is used in electronics, energy storage, sensors, and materials reinforcement. This application highlights the use of Raman microscopy for quality control of graphene produced by Chemical Vapor Deposition (CVD). The study revealed that monolayer graphene forms within Nickel (Ni) grains, while multilayer graphene accumulates along grain boundaries – all important parameters to assess the graphene's quality.



## Semiconductor - SiC Polytype Distribution

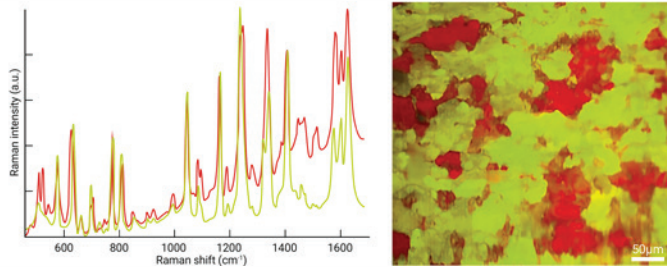


The RAMANdrive was used to assess differences in the crystal structure of an entire 4-inch SiC wafer in just 12 minutes. AreaFlash provided a low-resolution image in very short time (left), while laser line imaging revealed the finer details in the SiC polytype distribution (right). This approach efficiently balances quick initial assessment with the option for detailed analysis to drastically reduce total analysis time.





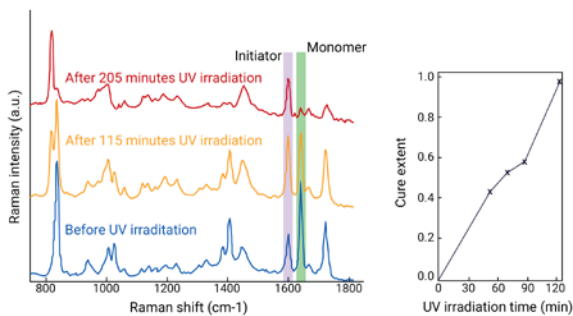
### Pharmaceuticals - Distinguishing API Polymorphs



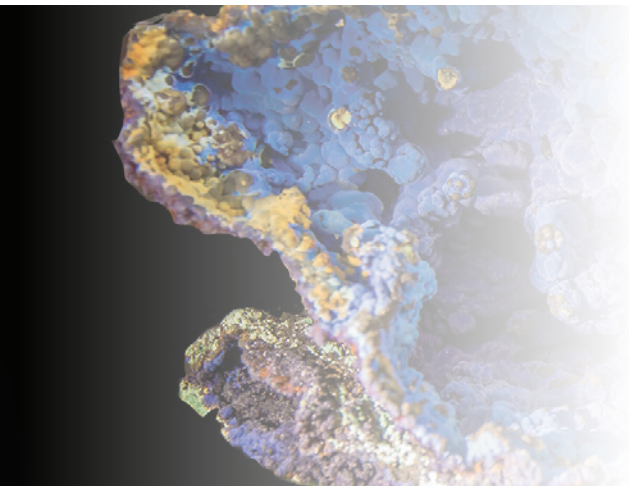
The crystallinity of a drug can affect therapeutic effects and absorption rates. Raman microscopy can assess the polymorphism of APIs non-destructively with no to minimal sample preparation. Here, the crystal polymorph distribution of mefenamic acid was determined, a painkiller with anti-inflammatory and antipyretic effects. The obvious differences in their Raman spectra were visualized in a Raman image, that clearly shows the random distribution of crystal form I (red) and form II (yellow).



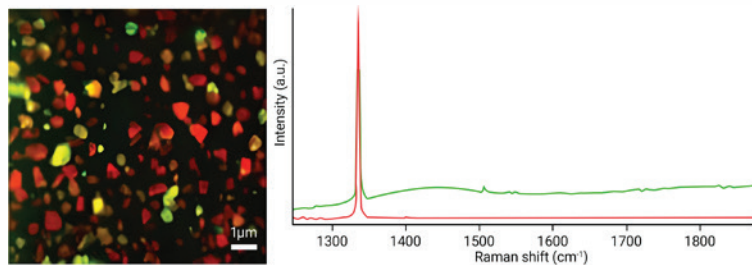
### Polymers & Plastics - Distribution of Degree of Curing



Raman spectroscopy can monitor polymerization reactions and curing processes in real-time by tracking molecular changes in the resin. In this example, Raman spectra of a resin sample were continuously collected and examined before and after UV irradiation of 115 and 205 minutes respectively. The degree of resin curing was determined by the intensity ratio of the peaks at  $1640\text{ cm}^{-1}$  and  $1598\text{ cm}^{-1}$ .



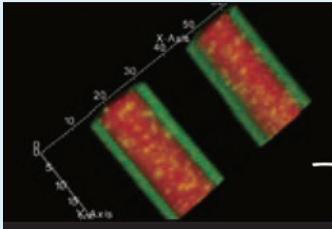
### Minerals - Analysis of Diamond Abrasive Surface



Diamonds used for abrasive surfaces require high crystallinity and must be evenly distributed. In this example, Raman imaging was used to reveal both parameters. On the right, the green spectrum diamonds show lower crystallinity compared to the red spectrum diamonds. Further examination shows that diamonds cover about 68.94% of the abrasive area, with nearly 61% being high-crystallinity diamonds (red).

# Hardware and Software

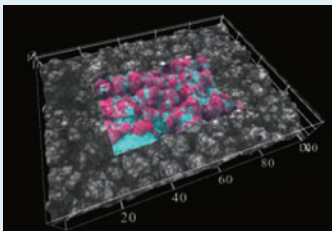
Advanced hardware and software for optimal results



## 3D Raman

*Three-dimensional observation with high speed and high spatial resolution.*

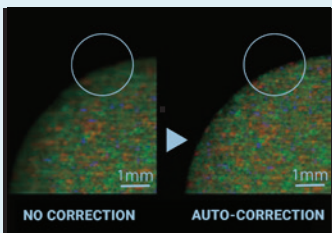
The advanced confocal system with a user-friendly GUI provides detailed 3D structures in transparent materials. This non-destructive technology with line illumination scanning achieves the highest-speed and highest-resolution imaging of Raman spectra in the world.



## Z-Track

*Tracking bumpy sample surfaces.*

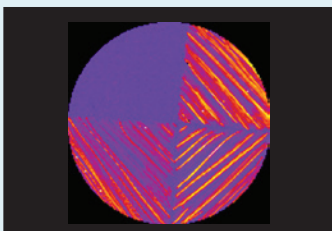
The surface profile of the sample is measured quickly and automatically from a series of optical microscope images at different heights. Raman mapping measurement is performed by adjusting the surface height at every laser focus location.



## Wide-Field

*High-speed wide field imaging follows the curve of the specimen surface.*

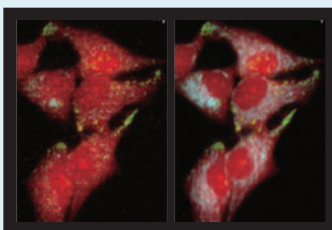
Combining the original laser scanning technology with stage scanning allows for scanning the entire sample surface using a high-speed imaging method. Samples with bumpy, tilted, or curved surfaces are also compatible with Z-Track and AreaFlash.



## AreaFlash

*High-speed bulk spectrum averaging.*

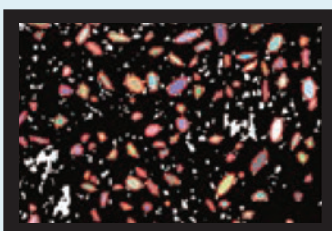
An averaged spectrum over a wide area in the FOV of the optical microscope can be obtained in a very short time. This technology is a powerful tool for fast screening and to monitor sample changes over time.



## Processing

*A variety of spectral preprocessing tools.*

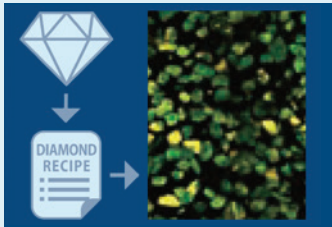
Baseline correction, differential spectrum processing, SVD noise removal and many other functions assist in reliable spectral analysis. A smoothing method with small influence on peak shape, the Kawata-Minami-Filter is also useful.



## Imaging

*Advanced spectral and image analysis algorithms.*

Multi-peak fit algorithm, real-time multivariate analysis during measurement, image correlation analysis, particle size analysis and other advanced Raman imaging analysis algorithms are available.



## Presetting

*Select a measurement target from the recipe.*

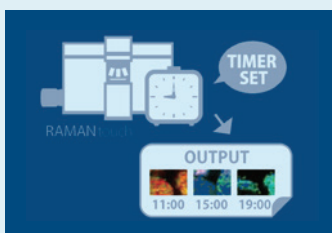
Complicated condition settings are no longer required. For first-time samples, all you have to do is select a similar substance from the registered recipes. For frequently measured materials, create your own unique “recipes” with the right measurement conditions.



## Remote Use

*You can measure and analyze even from remote locations.*

There's no need to always be next to the instrument to achieve excellent results. Once the sample is placed, RAMANtouch can be operated remotely from any computer.



## Scheduling

*Set your schedule in advance and focus on other tasks while the instrument does the job.*

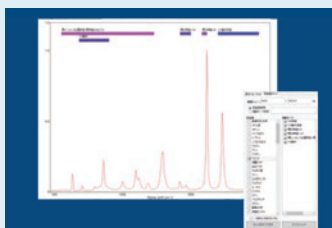
Minimized operator time. The reserved measurement function automatically performs measurements on a scheduled basis. Multiple measurement types and intervals are possible. If the focus shifts, it is automatically corrected to the preset condition before measurement.



## Random Walk

*Measurement time is reduced significantly by prioritizing relevant sample regions.*

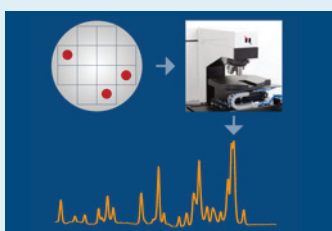
All Nanophoton Raman microscopes are equipped with a random walk scanning function, utilizing an ingenious beam scanning method based on stochastic process theory and information theory. Samples suitable for point scanning can also be scanned at high speed, leading to results in the shortest possible time.



## Reporting

*Substance identification support and report creation.*

Functional group guide that displays peak appearance region of functional group, interfacing with external databases, spectral library construction by users. Convenient functions for results creation and data exporting.



## Stage Navi

*Enjoy convenient interfacing.*

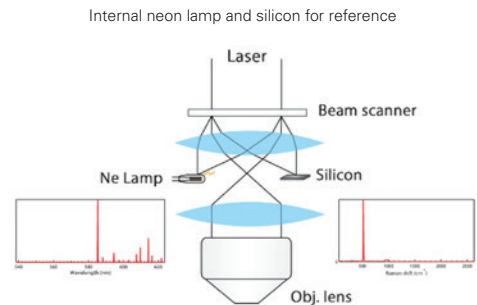
Simply upload data from your regular defect inspection tool and RAMANdrive identifies your areas of interest and moves the sample automatically to the requested positions for a detailed analysis.

# Spectroscopy Benchmarks



## Assured Maximum Performance due to Auto Alignment and Calibration

Nanophoton series microscopes feature automated alignment of the optical beampath. This assures maximum performance and long term stability without requiring manual adjustments. No expertise is needed to maintain a running instrument and high-quality measurements are guaranteed. Additionally, the RAMANfamily features an internal reference source and samples for calibration. This enables fully automatic wavenumber calibration without manual interaction with the system. Since wavenumber calibration can be performed even during measurement, it is possible to detect smallest variations of Raman peaks with highest accuracy.



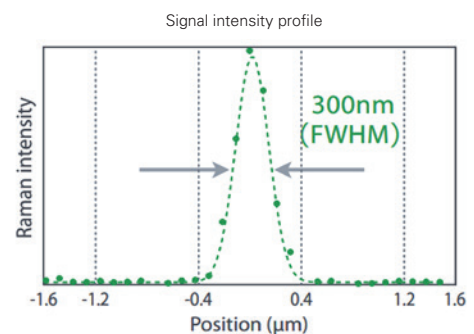
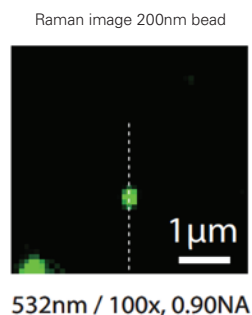
## Automated Measurements with Automated Hardware

Nanophoton instruments boast with complete system automation. From laser selection and adjustment of excitation power to motorized nosepiece and sample stage, every aspect of the measurement is software controlled. Complete automatization saves time and simplifies the operation of the microscope while assuring excellent reproducibility of results. The automated hardware of the RAMANfamily even allows convenient remote operation and advanced task scheduling.



## The Highest Resolution with any Objective Lens

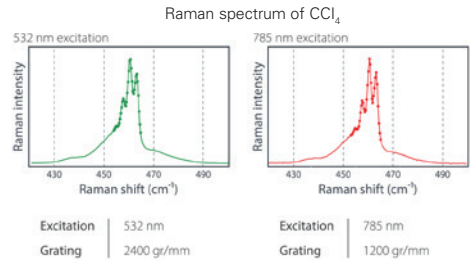
Independent of the choice of objectives or lasers, Nanophoton microscopes provide excellent spatial resolution thanks to their sophisticated confocal optical design. In the example of a 100x dry objective with 532 nm excitation, a lateral spatial resolution below 350 nm is demonstrated, achieving a depth resolution well below 1  $\mu\text{m}$ . Also, with lower magnification lenses the resolution reaches their theoretical limit, allowing versatility in objective choice while assuring best imaging performance in any measurement.





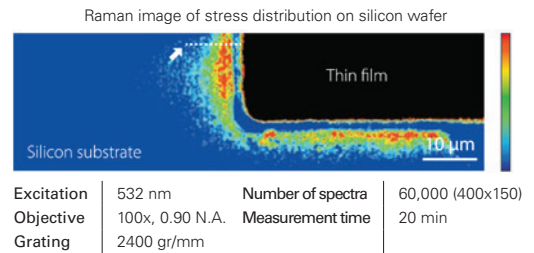
## High Spectral Resolution distinguishes Close Peaks

Highest spatial resolution and optimal throughput in a compact form factor. This is achieved using a powerful, patented spectrograph design with 550 mm focal length. The spectral resolution is approximately  $0.9 \text{ cm}^{-1}$  (FWHM) when a 785nm laser excitation wavelength is applied using a 1200 gr/mm grating. Even the Raman peaks of carbon tetrachloride that are used to evaluate spectral resolution can be observed respectively at both 532 nm and 785 nm excitation wavelengths.

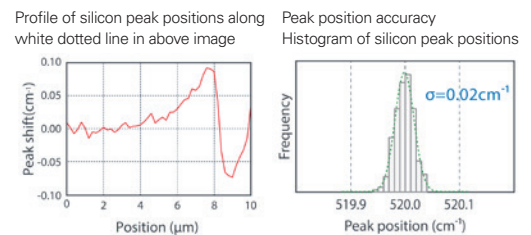


## Stable Peak Positioning enables High Accuracy Stress Analysis

The Raman peak position of silicon at  $520 \text{ cm}^{-1}$  shifts when the crystal lattice is distorted by stress. It shifts to higher wavenumbers under compressive stress, and shifts to lower under tensile stress. The amount of shift is proportional to the amount of stress imposed. The image at right is the Raman image of a silicon wafer with a thin film formed on its surface, colored by the stress distribution. The graph of the silicon peak position along the white dotted line in the Raman image shows stress distribution analyzed at a high accuracy of over  $0.1 \text{ cm}^{-1}$ .

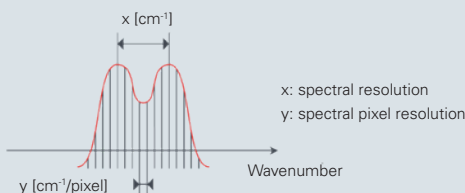


RAMANtouch has great repeatability and stability in Raman peak positions. The rightmost figure, which is a histogram of the peak positions of silicon, shows that the standard deviation of peak positions is within only  $0.02 \text{ cm}^{-1}$  (typical value using 532 nm laser excitation and 2400 grooves/mm grating).



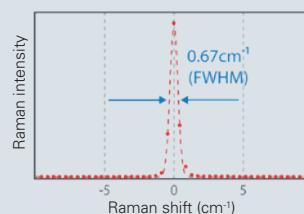
## Differences between Spectral and Pixel Resolution

Pixel resolution indicates the area ( $\text{cm}^{-1}$ ) per pixel of dispersed Raman light which hits the CCD. The more pixels the CCD has, the smaller the pixel resolution gets. However, smaller pixel resolution does not relate with higher spectral resolution.

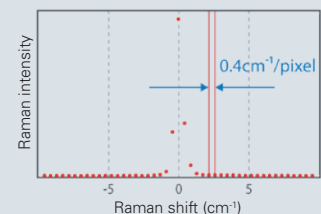


### Spectral resolution and pixel resolution

Spectral resolution (FWHM of Rayleigh scattered light)



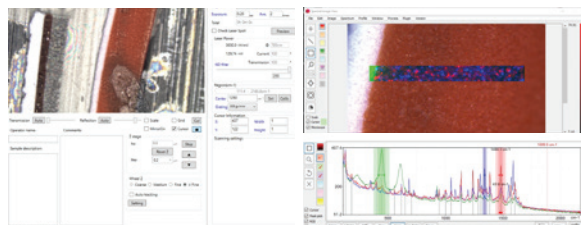
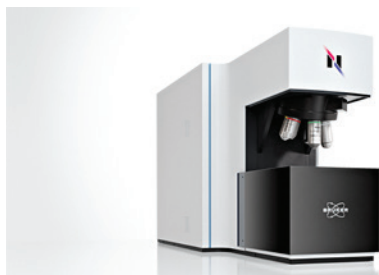
Spectral pixel resolution (Sampling interval)



Excitation | 785 nm      Grating | 1200 gr/mm

## YOU CAN COUNT ON US !

Raman is an exciting technology with incredible potential. Keep in touch with our engineers and specialists to unlock this potential by benefiting from our outstanding service and support team.



### Our hardware? **Simply mighty.**

We follow a simple philosophy in our hardware design and believe that high-quality automation is the best way to achieve maximum robustness, reliability, and ease-of-use.

Your system will never let you down, thanks to extensive system intelligence and our customer-centric service solutions. Highest performance and ease of operation is guaranteed.

### Our software? **Mighty simple.**

Our software is equipped with high-speed data processing capacity and miscellaneous analytical functions to support analysis of large, high-quality Raman imaging datasets.

Flexible file export options allow merging Nanophoton's data with other microscopic datasets and further give access to the sophisticated flexible AI-based evaluation tools in OPUS.

Covered by one or more of the following patents: US11442259B2; US10352862B2; US9927297B2; US9582088B2; US9435741B2; US20140063226A1; US20140002819A1; US20130162990A1; JP6923180B2; JP5998342B2; US7561265B2; JP5779963B2. Additional patents pending.

Laser class 1 product.

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**Bruker Optics is ISO 9001, ISO 13485,  
ISO 14001 and ISO 50001 certified.**

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